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A Review of the Ambush Bugs (Heteroptera: Reduviidae: Phymatinae) of Michigan: Identification and Additional Considerations for Two Common Eastern Species

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Abstract

A review of the two species of Phymatinae found in Michigan is presented, along with an identification key, distribution maps, and relevant literature. Also included are brief discussions concerning natural history, variation, distribution, past records, and two additional eastern species.

The ambush bugs are a group of predaceous insects named for their sedentary and surreptitious method of capturing prey. The robust habitus, incrassate terminal segments of the antennae, quadrate profemora, and raptorial forelegs render members of this group instantly recognizable. In the past, this group was afforded family status, but recent morphological and molecular studies have solidified the position of the Phymatinae within the Reduviidae (Weirauch 2008, Weirauch and Munro 2009). The ambush bugs are represented in the Nearctic region by 27 species in 3 genera (Froeschner 1988). Despite such modest diversity, the taxonomy of the ambush bugs is notoriously difficult to navigate. The confusion regarding the identity of past records, coupled with small interspecific morphological differences, makes identification a particularly arduous task. The works of Evans (1931) and Kormilev (1960) prove the most useful, although still difficult to apply, and the subfamily as a whole remains neglected compared to other heteropteran groups.

This neglect carries over to the species of Michigan. Among those publications enumerated by O'Brien (1983, 1988) as dealing with the terrestrial arthropods of Michigan, only two treat phymatine species: the short regional faunal lists by Townsend (1890) and Hussey (1922) documented the Heteroptera from the vicinity of Constantine, Saint Joseph County and Berrien County, respectively. Yet, even the identities of these records are difficult to interpret within the context of this group.

With the threefold purpose of clarifying records of the Phymatinae in Michigan, supplementing the survey of the Michigan Reduviidae (McPherson 1992) with the missing subfamily, and increasing the knowledge of the Michigan Heteroptera, I present herein a short review of the two species of ambush bugs known from Michigan.

Materials and Methods

The phymatine holdings of the two major university collections in southern Michigan were examined. County records were compiled, identification keys were modified, and the limited existing natural history information, both Michiganian and extralimital, was summarized.

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The identification of the 692 specimens included in this study was rendered or confirmed by the author. All specimens reside in one of the collections listed below unless otherwise noted. Collection dates indicate the earliest and latest adults examined and refer specifically to specimens collected in Michigan. Locations of Michigan counties from which specimens were collected are depicted in Figure 1.

In a group plagued by a nebulous association of names, the need to justify one's assignment of a name to an organism becomes paramount. Bortolus (2008, 2012) and Vink et al. (2012) summarized the problems surrounding the

Figure 1. The counties of the State of Michigan.

identification of specimens and the need for accountability and reproducibility in biological studies. *Phymata* Latreille, 1802 is a perfect example of a group where this necessity is crucial. The most recent revisionary work on the genus (Kormilev 1960) provides the basis for my identification of the Michigan species, and characters used in my key have been gleaned from that treatment.

The figures of the habitus, connexiva, and terminalia (Figs. 2-4) are provided to facilitate identification in a group rife with confounded and misidentified taxa. Furthermore, the two included species are widespread in eastern North America, and therefore, visual representation fills a gap important for multiple disciplines, wherein various studies might involve these commonly encountered insects. The conspecific male and female used in the figures were chosen from the same collecting event, and the same four individuals were used for each figure.

Collections are designated as follows: Daniel R. Swanson, personal collection (DRS); Albert J. Cook Arthropod Research Collection, Michigan State University, East Lansing, Michigan (MSUC); and University of Michigan Museum of Zoology Insect Collection, Ann Arbor, Michigan (UMMZ).

Results

Subfamily PHYMATINAE Laporte, 1832

Tribe PHYMATINI Laporte, 1832

Genus PHYMATA Latreille, 1802

Common and oft-encountered, the predatory ambush bugs are familiar elements of the Michigan entomofauna. Only the jagged ambush bugs, or members of the genus *Phymata*, are found in the state; members of the Macrocephalini have a more southern distribution. Of the 17 species of *Phymata* known from America north of Mexico (Froeschner 1988), only two species are found in Michigan: *Phymata americana* Melin, 1930 and *Phymata pennsylvanica* Handlirsch, 1897. Each species is widespread in the eastern states, and despite the nomenclatural turmoil, Froeschner (1988) correctly listed Michigan among both distributions.

A key for separating the two phymatine species found in Michigan is presented below. Males are easier to identify to species, owing to the sexual dimorphism in antennal and connexival characters, whereas females may prove difficult in this regard, especially with a small series or absence of males for comparison. Once familiarity with these species is attained, individuals often may be sexed by the connexival morphology, but examining the external genitalia (Fig. 5) is the most reliable method. Davis (1957) characterized the genitalia of various members of the subfamily, and the two species found in Michigan do not differ externally in these structures. Even if males are available, however, the characters in the key should be used with caution as there seems to be a great deal of variance and overlap between the species in these structures (Punzalan pers. comm., Swanson pers. obs.).

Key to the Phymatinae of Michigan

1 Fourth connexivum not abruptly dilated, lateral margin near junction of third and fourth connexivum more or less straight, outline of connexival segments 1-3 not smooth, often with small salient angles posterolaterally (Fig. 4); male with fourth antennal segment at most subequal in length to second and third combined; size slightly larger, length 8.5-10 mm.....*Phymata americana americana*

1' Fourth connexivum abruptly dilated, lateral margin near junction of third and fourth connexivum distinctly angulate, especially in the males, outline of connexival segments 1-3 entire, smooth, usually

Figure 2. Phymatinae of Michigan, dorsal habitus.

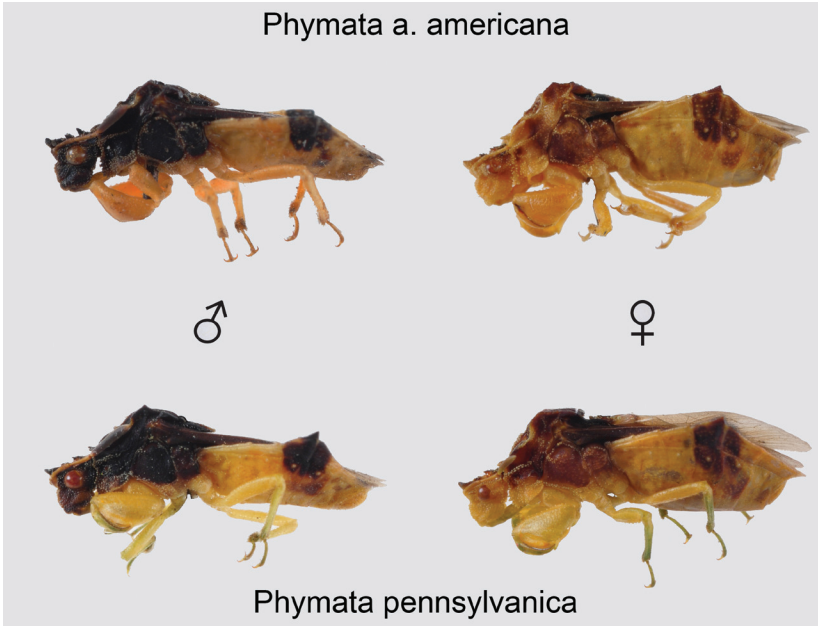

Figure 3. Phymatinae of Michigan, lateral habitus.

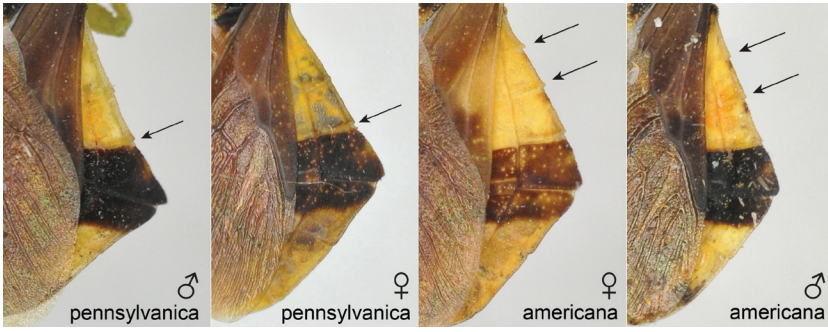

Figure 4. Phymatinae of Michigan, connexiva.

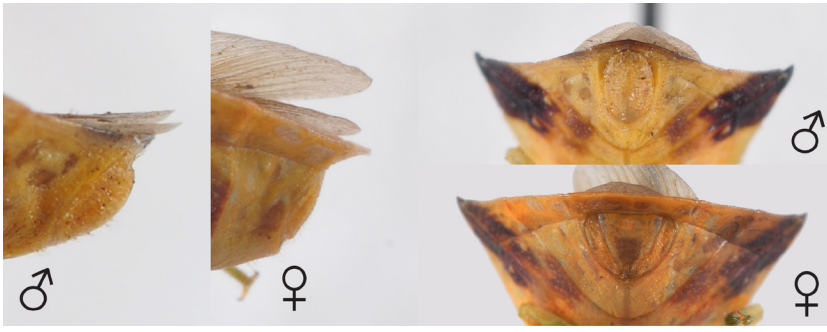

Figure 5. Terminalia of *Phymata*, lateral and caudal view.

without projecting angles posterolaterally (Fig. 4); male with fourth antennal segment distinctly longer than second and third combined; size slightly smaller, length 7.5-9 mm ..... *Phymata pennsylvanica*

Phymata americana americana Melin, 1930. (Figs. 2, 3, 4, 6). – The nominate subspecies is the only form found in Michigan. Hussey (1922) reported two specimens (as *P. erosa fasciata*) from New Buffalo (Berrien County), although Townsend's (1890) record of *P. erosa* also may refer to this species (see Clarification of Past Michigan Records below). 53 specimens examined. Collection dates from 23 July to 18 September.

Phymata pennsylvanica Handlirsch, 1897. (Figs. 2, 3, 4, 7). – In the very least, Townsend (1890) reported this species from Michigan as *P. wolffii* [sic] (see Clarification of Past Michigan Records below). Hussey (1922) wrote of this species (as *P. erosa wolfii* [sic]): "Moderately common. Adults were taken during the first week in September, at New Buffalo, at Three Oaks, and in the Warren Woods area. Nymphs were found as early as June 30." This species has been taken from foliage of sunflower (*Helianthus* sp.) in Lenawee County, milkweed (*Asclepias* sp.) in Oakland County, thistle (*Cirsium* sp.) and goldenrod (*Solidago* sp.) in Jackson County, and flowers of Queen Anne's lace (*Daucus carota* L.) in Berrien, Jackson, and Livingston counties. One collection in Isabella County was described as "sweeping fallow roadside. *Solidago* dominant. Some shrubs." Specimens in Livingston County also have been taken from tamarack (*Larix laricina* Du Roi) as well as several species of goldenrod (*Solidago juncea* Ait., *S. rigida* L.) and milkweed (*Asclepias verticillata* L., *A. incarnata* L., *A. erecta* De Wild.). Label data indicate a specimen from Van Buren County was taken "on *Eupatorium* sp. with *Boloria selene* [Nymphalidae] [prey]." A few individuals have been pinned with prey: *Diabrotica undecimpunctata* Mannerheim (Chrysomelidae: Galerucinae) in Jackson County, *Ctenucha virginica* (Charpentier) (Arctiidae) in Oakland County, *Apis mellifera* Linnaeus (Apidae) in Washtenaw County, *Hedychrum* sp. (Chrysididae) in Kalamazoo County, a female *Bombus* sp. in Livingston County, and an unidentified ichneumonid in both Lenawee and Livingston counties. In Michigan, *P. pennsylvanica* appears to be much more common than *P. a. americana*. 639 specimens examined. Collection dates from 10 June to 13 November.

Discussion

Natural History. The majority of biological studies on the Phymatinae in the United States have focused on the widespread *Phymata americana*, and each of the references in this subsection refers to that species. However, the behavior and life history reported in those studies likely apply to *P. pennsylvanica* and other *Phymata* species; therefore, the following discussion is presented in a more general context.

Readio (1927) and Balduf (1941) documented the life history in Kansas and Illinois, respectively; the basic framework is outlined here. Ambush bugs are commonly encountered in open sunny areas sitting on flowers and snatching up any of the various insects visiting or frequenting the blossoms. They are univoltine; in Michigan, as in other parts of the eastern United States, the nymphs start to appear in middle to late June, and the adults become more abundant in middle to late July and often are found through much of October. During this time, males and females exhibit two types of [partnered] behavior designated as coupling and copulation (Balduf 1941). In coupling, the male rides on the dorsum of the female. In this configuration, both may attack and take down prey too large for a single insect or each may take individual prey for consumption. Females also have been observed toting two males simultaneously. Balduf (1941) noted a distinct rise in the number of couples as the season progressed. In contrast, copulation occurs with the male clutching the side of the female with the terminalia united and heads diverging; thus, the

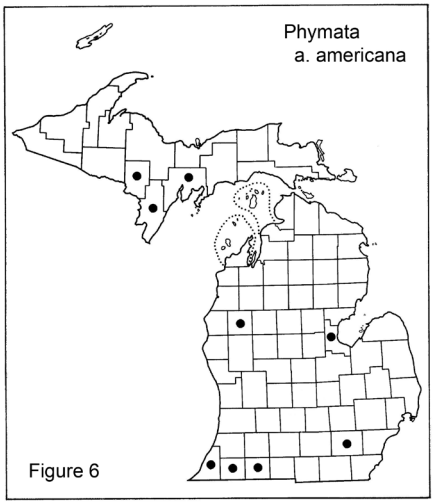

Figure 6. Distribution of *Phymata americana americana* in Michigan.
Figure 7. Distribution of *Phymata pennsylvanica* in Michigan.

pair together form a V shape. After mating takes place, the female lays eggs, presumably on grasses or other short non-woody vegetation, and these eggs overwinter and hatch the following year.

Balduf compiled prey lists (1939, 1940, 1943), which indicated that these insects are opportunistic generalist predators, with the most frequent prey being pollinators visiting the flowers on which the ambush bugs sit. Balduf (1942) also reviewed the economic impact of these insects (under the combination *Phymata pennsylvanica americana*) in the eastern United States; he generally found that ambush bugs consume as many beneficial insects as pestiferous ones and, therefore, should be neither destroyed nor cultivated for use in pest management. I encountered during my survey of the literature no reports of cannibalism for *Phymata* species, an association not uncommon among other reduviids (e.g., Ryckman 1951, Hays 1965, Ambrose 1986, Thomas and Manica 2003, Swanson pers. obs.).

Inter- and Intraspecific Variation. As previously mentioned in the Introduction, the paucity of consistent morphological differences has made it difficult to characterize species in *Phymata*. This difficulty is clearly exemplified in the two species found in Michigan. To my knowledge, however, no comparative studies of the genitalia of the North American *Phymata* have been made, and an examination of these structures might provide reliable characters for elucidating relationships. Furthermore, the close distributional proximity of many species, coupled with an apparent lack of external diagnostic characters, may allow for the possibility of hybridization (Punzalan pers. comm.; Swanson pers. obs.), contributing to the difficulty of delimiting species. Thus, studies of the margins of populations, viz. potential zones of overlap, also may shed light on interspecific relationships of these and other species of *Phymata*.

Equally confounding is the high level of intraspecific variation within populations, including morphological structures (e.g., antennal ratios, connexival shape, dorsal and lateral granulation) and color pattern, compounded by appreciable levels of sexual dimorphism. These phenomena may have significant influences from both ontogenic and environmental factors (Punzalan pers. comm.). Mason (1973) studied the variation of populations in New York, emphasizing the differences between disturbed and undisturbed habitats. Several recent

studies (Punzalan 2007; Punzalan et al. 2008a; Punzalan et al. 2008b, 2008c, 2010) have investigated various factors, such as thermoregulation, sexual selection, and resource availability, affecting some of these sexually dimorphic traits, particularly color pattern. Understanding these complicated interrelationships also may have important implications for the evolution of the group.

Distribution in Michigan and Resulting Considerations. The results of this study raise questions about the distribution of the ambush bugs. In particular, the abundance of *P. pennsylvanica* contrasts the relative scarcity of *P. americana* in Michigan. Yet, both are native species, being widespread in the eastern United States, and both were known from Michigan at the beginning of the twentieth century. These distributional results are especially puzzling in view of the wide transcontinental range of *P. americana* and are underscored by the two species appearing to be sympatric (occasionally even syntopic) as well as synchronic.

These characteristics, contrary to those predicted for species occupying a standard ecological niche, might be explained by their natural history. Generalist predators are not competing for a particular food source as they simply grab anything passing that can be subdued. This is especially relevant for the particular habitat because sundry pollinators are often abundant. The low level of vagility perceived for the species also supports this idea. If the phymatines are, in fact, relatively inactive, individuals might simply remain near their hatching site rather than disperse into new habitats, thereby decreasing new opportunities for competition. Admittedly, there might be problems with this scenario as the high level of intraspecific variation in this group may not be supported by a decreased level of gene flow; yet, to date, essentially nothing is known of the population genetics of *Phymata* species (Punzalan pers. comm.). It also is possible that one species (here, *P. pennsylvanica*) is more resilient to habitat alterations or responds more quickly in colonizing disturbed sites, an increasingly salient consideration in light of the growing amount of human development in the last century (e.g., construction of highways and railroads, urban sprawl, drainage, invasive species removal). As mentioned above, there are localities in Michigan (e.g., Berrien County) where the species are thought to occur together; thus, the implications of hybridization, if demonstrated to exist in *Phymata*, could apply to Michigan populations. Unfortunately, these questions are beyond the intended scope of this study and raised only to draw attention to potential areas for further investigation.

Clarification of Past Michigan Records. As previously indicated, the identity of the Michigan records of *Phymata* given by Townsend (1890) and Hussey (1922) require some minor unraveling. Kormilev (1960) stated "Handlirsch asserts that *P. wolffi* is a mixture of at least three subspecies of [*P.*] *erosa*: *P. fasciata* Gray, *P. pennsylvanica* Handlirsch, and *P. granulosa* Handlirsch (three different species and not subspecies *erosa*)." Thus, it may be assumed that Townsend's (1890) record of *P. wolffii* [sic] and Hussey's (1922) record of *P. erosa wolfii* [sic] refer to *P. pennsylvanica*. Furthermore, Kormilev (1960) stated "Handlirsch has united by the name *P. erosa* ssp. *fasciata* at least two species: *P. fasciata* (Gray) and another, later described by Melin as *P. americana*." Thus, Hussey's (1922) record of *P. erosa fasciata* is assigned to *P. americana*. More difficult to place are Townsend's records of *P. erosa* (Linnaeus, 1758) (erroneously ascribed to Herrich-Schaeffer) and *Phymata acutangula* (Guérin, 1857). The record for *P. erosa* may refer to either *P. americana* or *P. pennsylvanica*. As Townsend had already listed *P. wolffii* [sic], it seems more likely that this record referred to *P. americana*. The record for the Cuban *P. acutangula* is treated as erroneous because the *Phymata* species previously confounded with *P. acutangula* would not occur in Michigan (although the dilated fourth connexiva would more closely resemble *P. pennsylvanica*). Hussey (1921) also doubted this record. These Michigan records are discussed merely in an attempt at clarification, as I have examined specimens of both *P. americana* and *P. pennsylvanica* from each of Berrien and Saint Joseph counties.

Notes on Additional Eastern Species. *Phymata vicina vicina* Handlirsch, 1897 is another species widely distributed in the eastern United States. It is known from Alberta, Arizona, British Columbia, Colorado, Connecticut, Florida, Illinois, Indiana, Kansas, Manitoba, Massachusetts, Nebraska, New Jersey, New York, Pennsylvania, Rhode Island, Saskatchewan, South Dakota, Texas, Utah, and Virginia as well as Washington, D.C. (Froeschner 1988, Maw et al. 2000). The northern U.S. records of this species (IL, IN, ND, NY) and southern Canada suggest *P. vicina* may eventually be found in Michigan. This species may easily be recognized by its small size (5-6.5 mm), whereas the species known from Michigan (and the following species) are larger (8+ mm).

Phymata fasciata (Gray, 1832), a species widespread in the United States, is not recorded from Michigan and probably does not occur in the state. The following comments are offered because of the confusion associated with the name (see Clarification of Past Michigan Records above). The two subspecies of *P. fasciata* have a more southerly distribution: Arizona, "Carolina," Florida, Georgia, Louisiana, Mississippi, and Texas (Froeschner 1988). This species has the posterolateral angles of the first three connexival segments noticeably protruding and dentiform, in addition to an abdomen dilated abruptly from the fourth connexivum; this combination of characters is not present in the species found in Michigan.

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